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54 **Sterilization process.**

57 A sterilization arrangement which is adaptable to pumpable fluid-carrying packages on a conventional forming, filling and sealing machines as they are conveyed intermediate the turret for forming and sealing one end of the cartons and the section for filling and sealing the other end thereof. The process involved includes the following steps: spraying an up to 35% solution of hydrogen peroxide at room temperature into the open ends of paperboard packages having one sealed end resulting in a 300-400 parts per million concentration in the package; conveying the packages through an outside heating section very nearly in contact with a stationary cover member, while blowing hot air at a temperature in the range of 340-400° F upwardly past the packages; conveying the cartons beneath and very nearly in contact with the stationary cover member extending along the length of a sterilization section and subjecting the packages to surrounding air at a temperature of 200-230° F; drying the packages in a drying section by directing sterile air at a temperature of 200-240° F into the open tops of the cartons, with

the hydrogen peroxide concentration being reduced to a maximum of 0.05 parts per million; and unloading the respective sterilized cartons into the filling and final end sealing section.

## STERILIZATION PROCESS

### TECHNICAL FIELD

This invention relates generally to sterilization processes and, more particularly, to a sterilization process for packages using hydrogen peroxide sterilant.

### BACKGROUND ART

The previous method of blowing hot air into a carton into which hydrogen peroxide has been sprayed causes the liquid hydrogen peroxide to be immediately vaporized and expelled from the carton. The necessary time duration factor is uncontrollable and is too short for effective sterilizing.

Other means have been attempted other than generating a hydrogen peroxide and water vapor atmosphere within the carton. Such other process involves generating a hydrogen peroxide vapor in a circulating loop and applying this vapor to an open carton relying on condensation to distribute the hydrogen peroxide within the carton. It has not been effective with minimal kill rate resulting.

Various methods of dipping and/or spraying of hydrogen peroxide sterilant, in combination with heating, are described in Moore et al patent no. 4,169,123; Lothman et al patent no. 4,225,556; Lisiecki patent no. 3,566,575; Spisak et al patent no. 4,566,251; and Muller et al patent no. 4,631,173.

### DISCLOSURE OF THE INVENTION

An object of the present invention is to provide an improved high-speed sterilization method which is efficient and effective for open ended thermoplastic coated paperboard packages.

Another object of the invention is to provide an improved sterilization method which may be used in conjunction with a conventional indexing type forming, filling and sealing machine, intermediate one end forming and sealing operation, and the filling and other end forming and sealing operation on the machine, such as the intermediate sterilization section of patent no. 4,556,251.

A further object of the invention is to provide a high-speed sterilization process which achieves a consistent index spore reduction of at least 8D with hydrogen peroxide residuals under 0.1 ppm in conventional paperboard packages..

A still further object of the invention is to provide a sterilization method including the steps of (a) spraying air up to 35% hydrogen peroxide solution, resulting in a 300-400 parts per million concentration, at room temperature, or approximately 70° F, into open ended paperboard cartons after the cartons leave the typical turret on which one end closure thereof will have been formed and sealed; (b) moving each carton through an outside heating section just beneath a stationary cover member, while blowing hot air at a temperature in the range of 340-400° F upwardly and sidewardly past the packages, raising the inside temperature of the hydrogen peroxide film to approximately 160° F; (c) conveying the cartons beneath the stationary cover member extending through a sterilization section, very nearly in contact therewith, and subjecting the outside surfaces of the cartons to air at a temperature in the range of 200-230° F, raising the inside temperature of the hydrogen peroxide film to approximately 190° F; (d) conveying the cartons away from the cover member into a drying section and drying the cartons with sterile air at a temperature in the range of 200-240° F directed into the open ends of the cartons, raising the inside temperature of the hydrogen peroxide film to approximately 210° F and resulting in a maximum hydrogen peroxide concentration of 0.05 parts per million; and unloading the sterilized and dried cartons from the drying section onto a conveyor adapted to carrying the cartons through the filling and final end sealing stations.

These and other objects and advantages of the invention will become more apparent when reference is made to the following description and accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram illustration of the steps involved in the method of the invention, including an optional intermediate step;

FIGURE 2 is a schematic illustration of the structure utilized to carry out the method embodied in Figure 1;

FIGURE 3 is an enlarged cross-sectional view taken along the plane of the line 3-3 of Figure 2, and looking in the direction of the arrows; and

FIGURE 4 is an enlarged view of a portion of the Figure 2 structure.

### BEST MODE OF CARRYING OUT THE INVENTION

Referring now to Figure 1, there is illustrated a block diagram depicting the following progressive steps:

A. Spraying an approximately 35% solution of hydrogen peroxide, resulting in a concentration of 300-400 parts per million, at room temperature, say 70° F, into the open tops of paperboard cartons after they have been stripped from respective mandrels of a forming, filling and sealing turret whereupon one of the end closures of the cartons were formed and sealed;

B. Conveying each carton through an outside heating section beneath a stationary cover member nearly in contact therewith, while blowing hot air at a temperature in the range of 340-400° F upwardly past the cartons, raising the inside temperature of the hydrogen peroxide film to approximately 160° F;

C. Conveying the cartons through a sterilization section beneath a stationary cover member very nearly in contact therewith and subjecting the outside surfaces of the cartons to sterile air at a temperature in the range of 210-230° F, raising the inside temperature of the hydrogen peroxide film to approximately 190° F;

D. Conveying the cartons away from the cover member and drying the cartons with sterile air at a temperature in the range of 200-240° F directed into the open ends of the cartons, raising the inside temperature of the hydrogen peroxide film to approximately 210° F and reducing the hydrogen peroxide to a range of 0.01-0.05 parts per million; and

E. Unloading the sterilized and dried cartons from the drying section onto a conveyor adapted to carrying the cartons through the filling and final end sealing stations.

As further illustrated in Figure 1, the above step D may be changed to two stations with inside-directed air at 300-320° F, raising the inside temperature of the hydrogen peroxide film to approximately 200° F; followed by two stations, rather than six, with the inside-directed air at 220-240° F, resulting in a hydrogen peroxide reduction to a minimum concentration of 0.05 parts per million.

Referring now to the apparatus 10 utilized for the above described method, as represented in Figure 2, there is illustrated a loading section 12, a spraying section 14, an outside heating section 16, a sterilization section 18, a drying section 20, and an unloading section 22, with conveyor means therethrough represented at 23 and having an index time of 3.2 seconds. A pair of spray nozzles 24 and 26 are offset from the center of the packages on alternate opposite sides of the center as each package progresses, for spraying the hydrogen

peroxide in step A twice into each package in the spraying section 14 for optimum interior surface coverage.

A heat plenum 28 and exhaust units 30 are operatively connected respectively below the closed ends and above the open ends of the packages, with hot air being directed past the packages from the heat plenum to the exhaust units for the outside heating operation in the section 16, as described in step B above. This air is alternately directed at angles of 5° below horizontal and 5° above horizontal at alternate stations, as represented at outlets 32 and 34 of the heat plenum 28 in Figure 2, and shown in Figure 3.

A stationary cover member 36 is mounted along the lengths of each of the outside heating section 16 and the sterilization section 18, with the cartons moving therepast very nearly in contact therewith, with sterile air, as described in step C above, provided from a heat plenum 38 to exhaust units 40, through the plenum outlets 32 and 34.

As shown in Figure 3, in addition to hot air flowing past the lengths of the packages, from the closed ends to the open ends thereof, hot air may be directed laterally past the sides of the packages from outlets 42, particularly during index dwell periods, for each of the seven stations of section 16 and the eight stations of section 18.

A heat plenum 44 in the drying section 20 serves to provide sterile air through a plurality of outlets 46a, 46b, 46c, 46d, 46e and 46f into the open tops of the packages. Specifically, the outlets are variously offset from the centers of the respective packages as they dwell beneath the outlets, as shown in Figure 4, providing an effective sweeping pattern of the sterile air in the Packages.

#### INDUSTRIAL APPLICABILITY

It should be apparent that the invention provides an efficient and effective sterilization arrangement which is adapted to being mounted on a forming, filling and sealing machine, intermediate the ends forming and sealing turret and the filling and other end sealing stations thereof.

More specifically, in this arrangement, the packages are sprayed with up to 35% solution of hydrogen peroxide and indexed into heating stations where the carton is covered to retain a generated vapor atmosphere of hydrogen peroxide and water. Hot air is directed in a precise manner to the outside surfaces of the package to evenly increase the package's inside surface temperatures. The liquid hydrogen peroxide and water mixture is vaporized as the inside surface temperature rises. The water is more easily vaporized at lower tem-

peratures and as the package inside surface temperature rises during heating the liquid mixture remaining on the package surfaces become increasingly more concentrated with hydrogen peroxide. This increase in concentration of hydrogen peroxide contributes to a higher microbiological kill rate.

Simultaneously, as the peroxide vapor increases inside the carton, its partial pressure increases. This causes the liquid peroxide remaining on the package surfaces to vaporize at even higher temperatures. The higher temperature peroxide liquid, in intimate contact with the package's inside surfaces, results in an even higher kill-rate.

The circulating vapor inside the package will condense out on the cooler surfaces of package. This results in heating of these cooler surfaces and an improvement in their respective kill-rate contribution.

The circulating hydrogen peroxide vapor inside the carton volume has an additive sterilizing effect on these hot surfaces where the peroxide liquid has been completely vaporized.

The sterilizing factors of (1) the concentration of the liquid peroxide sterilant (2) the temperature at which sterilization occurs, (3) the intimate contact of the sterilant with the surface to be sterilized, and (4) the time elapsed of the sterilization process are all controlled by this outside heating process.

While but one embodiment of the invention has been shown and described, other modifications thereof are possible within the scope of the following claims.

## Claims

1. A sterilization method comprising the steps of:

(a) Spraying a predetermined solution of hydrogen peroxide at room temperature into the open ends of paperboard packages having one sealed end closures;

(b) Conveying the packages beneath a stationary cover member with the open ends very nearly in contact therewith and subjecting the outside surfaces of the cartons to hot sterile air at a first predetermined temperature while indexing through a predetermined number of stations;

(c) Conveying the cartons beneath the stationary cover member with the open ends very nearly in contact therewith and subjecting the outside surfaces of the cartons to sterile air at a second lower predetermined temperature while indexing through a predetermined number of stations;

(d). Conveying the cartons away from the cover member into a drying section and drying the

cartons through a predetermined number of stations with sterile air at a third predetermined temperature intermediate said first and second predetermined temperatures directed into the open ends thereof, resulting in a final desired maximum in parts per million of hydrogen peroxide; and

(e) Unloading the sterilized and dried cartons onto a conveyor adapted to carrying the cartons through the filling and final end sealing stations.

2. The sterilization method described in claim 1, wherein the spraying step (a) occurs on a forming, filling and sealing machine just after the open ended cartons are stripped from respective mandrels thereof whereupon the one of the ends thereof was formed and sealed.

3. The sterilization method described in claim 1, wherein the predetermined solution of hydrogen peroxide is approximately up to 35% solution, resulting in a concentration in the range of 300-400 parts per million.

4. The sterilization method described in claim 3, wherein said first predetermined temperature is in the range of 340-400° F.

5. The sterilization method described in claim 4, wherein said second lower predetermined temperature is in the range of 200-230° F.

6. The sterilization method described in claim 5, wherein said third predetermined temperature is in the range of 200-240° F and said reduction in hydrogen peroxide results in a concentration in the range of 0.01-0.05 parts per million.

7. The sterilization method described in claim 1, wherein the step (a) occurs over two stations, and room temperature is considered to be approximately 70° F.

8. The sterilization method described in claim 1, wherein the step (b) occurs over seven stations.

9. The sterilization method described in claim 1, wherein the step (c) occurs over eight stations.

10. The sterilization method described in claim 1, wherein the step (d) occurs over six stations.

11. The sterilization method described in claim 1, wherein the time for each index is approximately 3.2 seconds.

12. The sterilization method described in claim 4, wherein the packages attain an inside hydrogen peroxide film temperature of approximately 160° F.

13. The sterilization method described in claim 5, wherein the packages attain an inside hydrogen peroxide film temperature of approximately 190° F.

14. The sterilization method described in claim 6, wherein the cartons attain an inside hydrogen peroxide film temperature of approximately 210° F.

15. The sterilization method described in claim 1, and a step intermediate steps (c) and (d) of drying the cartons through two stations with sterile air at a temperature in the range of 300-320° F directed into the open tops of the cartons.

16. The sterilization method described in claim 15, wherein the step (d) occurs over two stations.

17. The sterilization method described in claim 15, wherein the cartons attain an inside hydrogen peroxide film temperature of approximately 200° F.

18. The sterilization method described in claim 4, wherein the air at said 340-400° F and at said 200-230° F is a continuous flow of hot air from adjacent the sealed ends of the cartons past the sides thereof.

19. The sterilization method described in claim 18, wherein said hot air is directed at 5° off vertical at alternate stations throughout the steps (c) and (d).

20. The sterilization method described in claim 18, and blowing hot air laterally past the sides of the cartons during the conveyor dwell time.

21. The sterilization method described in claim 6, wherein the sterile air at 220-240° F is directed into the open ends of the cartons in a manner alternating between leading and lagging the carton center, so as to sweep the carton interiors uniformly.

22. A sterilization method comprising the steps of:

(a) Spraying an up to 35% hydrogen peroxide solution, resulting in a concentration of 350 to 400 parts per million, at room temperature, or approximately 70° F, into open ends of paperboard packages after the packages leave the typical turret on which one end thereof will have been formed and sealed;

(b) Conveying the packages beneath a stationary cover member in an outside heating section with the open ends very nearly in contact therewith, while blowing hot air at a temperature in the range of 340 to 400° F past the packages from the closed to the open ends thereof, raising the inside temperature of the hydrogen peroxide film to approximately 160° F;

(c) Conveying the cartons beneath the stationary cover member in a sterilization section with the open ends very nearly in contact therewith, while subjecting the outside surfaces of the cartons to sterile air at a temperature in the range of 200 to 230° F, raising the inside temperature of the hydrogen peroxide film to approximately 190° F;

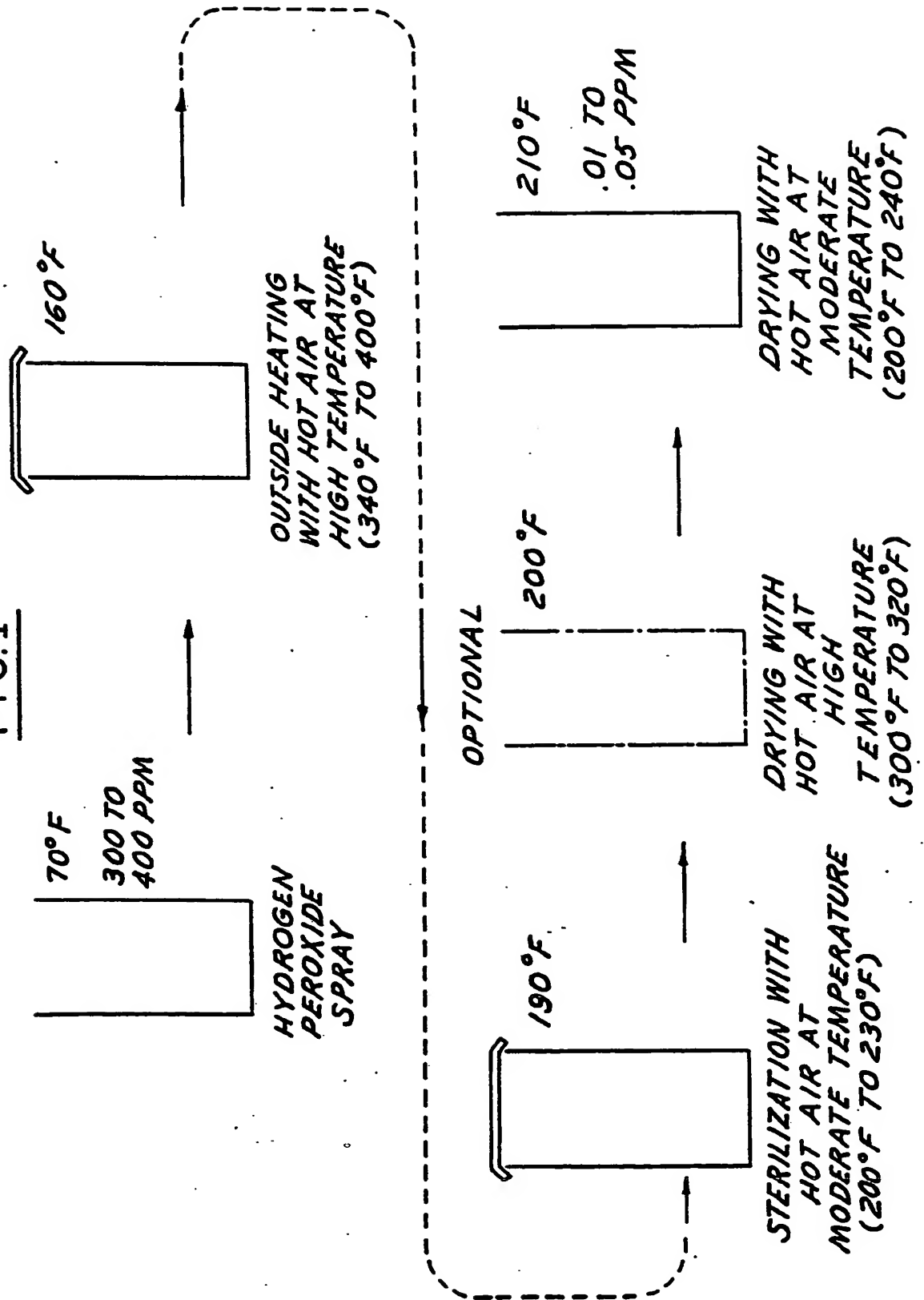
(d) Conveying the cartons away from the cover member into a drying section and drying the cartons with sterile air at a temperature in the range of 200 to 240° F directed into the open ends of the packages, raising the inside temperature of the hydrogen peroxide film to approximately 210° F and resulting in a maximum hydrogen peroxide concentration of 0.05 parts per million;

(e) Unloading the sterilized and dried packages onto a conveyor adapted to carrying the packages through the filling and final end sealing

stations.

23. The sterilization method described in claim 22, and a step intermediate steps (c) and (d) of drying the cartons with sterile air at a temperature in the range of 300-320° F directed into the open ends of the cartons, raising the inside temperature of the hydrogen peroxide film to approximately 200° F.

FIG.1





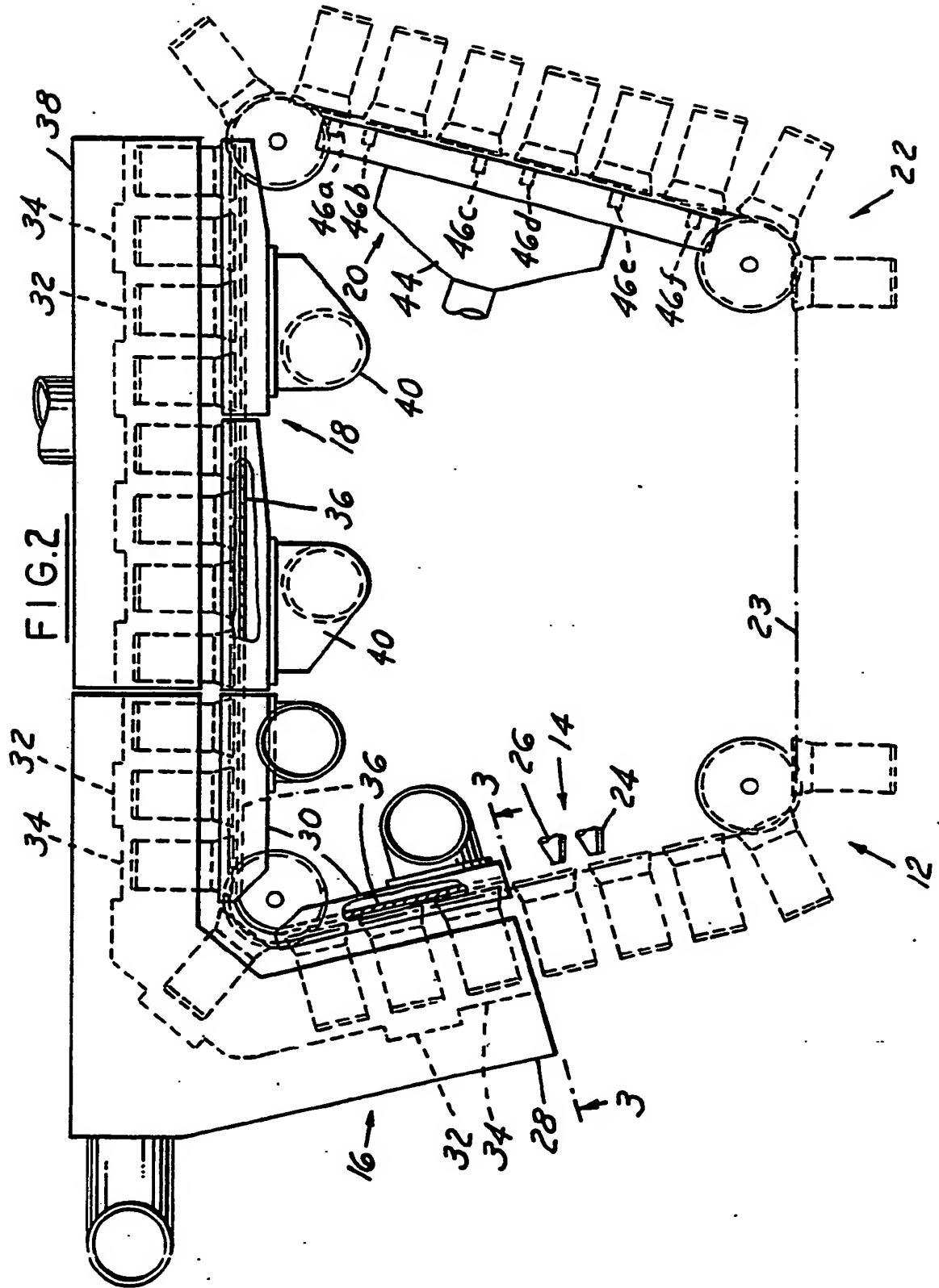


FIG. 4

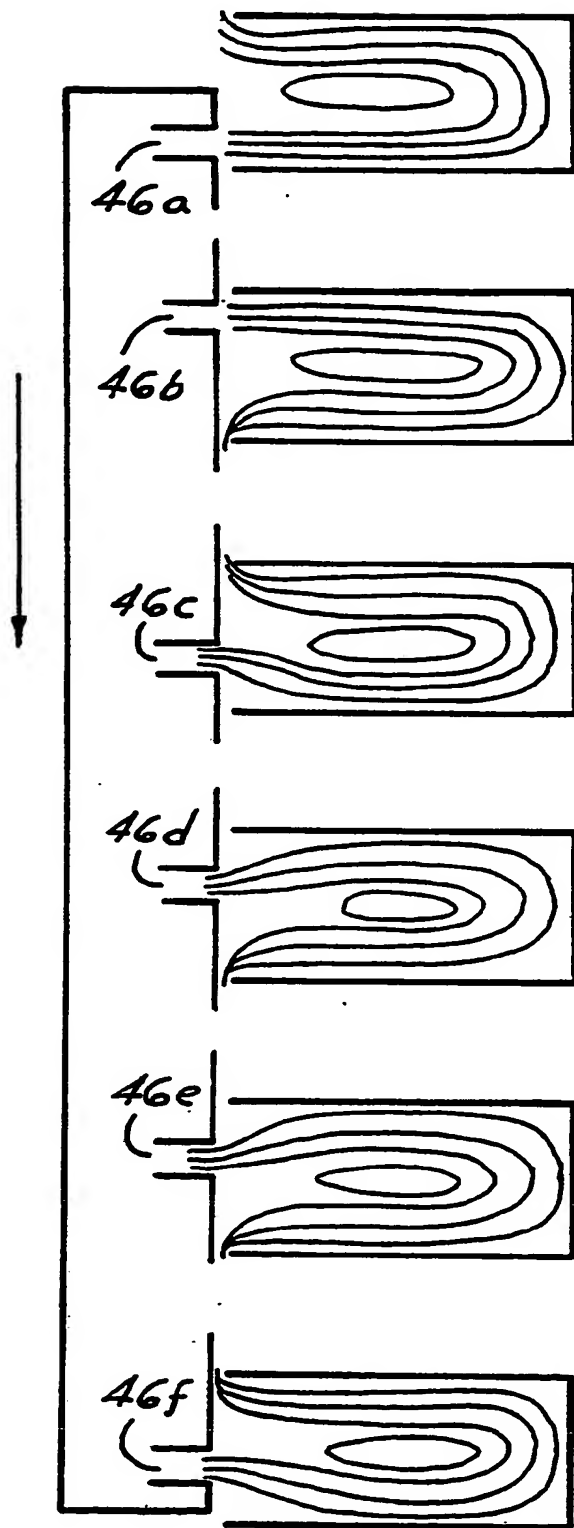
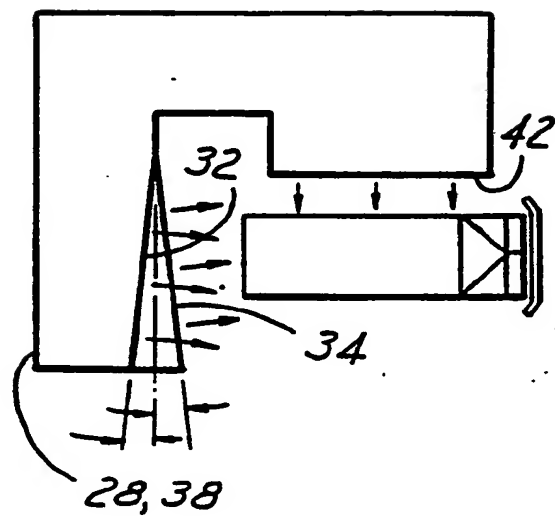


FIG. 3





European Patent  
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# EUROPEAN SEARCH REPORT

Application Number

EP 89 31 2192

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A, D	FR-A-2 516 473 (JAGENBERG) * Page 7, line 21 - page 8, line 28; figure 1 *	1,3,22	B 65 B 55/10
A	US-A-3 899 862 (LEVER) * Column 4, line 64 - column 5, line 31; figures 1-3 *	1,22	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B 65 B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 12-03-1990	Examiner CLAEYS H.C.M.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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